

A Calibration-Independent Technique of Measuring Soot by Laser-Induced Incandescence Using Absolute Light Intensity*

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ABSTRACT

Laser-induced incandescence (LII) has been proven to be a useful diagnostic tool for spatially and temporally resolved measurement of particulate (soot) mass and volume fraction, and primary particle size in a wide range of applications such as steady flames, flickering flames, and diesel engine exhausts. In this technique, a high-energy pulsed laser is used to rapidly heat the soot particles in the measurement volume to temperatures significantly above the local flame temperature. Analysis of the incandescence signals emitted by the heated soot particles yields information on the local soot volume fraction and the primary particle size. To make quantitative measurements of concentration there is a need for a calibration. Conventionally, the calibration is performed in a source of particles with a known particle volume fraction or particle concentration. This paper presents a novel technique for the determination of soot volume fraction by LII using absolute light intensity measurements, avoiding the need for a source of particles with a known soot volume fraction, and thus extending the capabilities of LII for making practical quantitative measurements of soot. The sensitivity of the detection system is determined by calibrating with an extended source of known radiance and then this sensitivity is used to interpret the measured LII signals. Although it requires knowledge of the soot temperature, either from a numerical model of soot particle heating or experimental observation of the soot temperature, this approach offers a calibration independent technique for measuring soot volume fraction by LII.

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